

Device and Method for Controlling Flicker in Liquid Crystal Shutter Glasses
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2 BACKGROUND OF THE INVENTION

3 1. Field of the Invention

4 This invention relates to a device and method for reducing flicker perceived
5 in an image viewed through liquid crystal shutter glasses.

6 2. Prior Art

7 Liquid crystal shutter glasses (**LCSG**) are used in time-sequential
8 stereoscopic 3D systems to control which image the viewer's eyes receive. Worn by the
9 viewer, they are designed to "open" and "close" (i.e., to transmit light or to block light
10 going to each eye) synchronous with and in the same sequence as the left and right images
11 are presented to a monitor or a projector. Only one shutter is open at a time. **LCSG** are
12 usually designed for the "active-closed" configuration, that is, the shutter closes when a
13 high voltage is applied. However, the principle set forth in this discussion apply equally to
14 "active-open" configurations.

15 **LCSG** have three parts: 1) a "front" linear polarizer, 2) the LC cell, and 3)
16 a "rear" linear polarizer. The front ~~and~~^d rear polarizers are crossed, i.e., they are oriented
17 90° to each other for the "active-closed" design.. For **LCSG** having an "active-open"
18 design the orientation of the polarizers is parallel. In the open state, when no voltage is
19 applied across the LC layer, the layer of LC material in the cell acts as a half-wave
20 retarder. The LC layer rotates the axis of polarization of light passing therethrough by 90
21 degrees. Therefore, light passing through the first polarizer of the crossed polarizers
22 passes through the second polarizer without significant attenuation. In the closed state,

- the LC does not rotate the polarization with the result that the light is then blocked by the crossed polarizers.

3 If the refresh rate on the screen of the display device is not fast enough,
4 such as in standard NTSC/PAL television systems, flicker will be observed by the viewer.
5 However, it is well known that flicker can be minimized by reducing the illumination of the
6 viewed scene. One common method for doing this is to place a neutral density (ND) filter
7 within the shutter glasses.

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SUMMARY OF THE INVENTION

11 It is a primary object of this invention to provide a device for viewing an
12 image which reduces flicker in the image perceived by a viewer.

13 The features of the invention believed to be novel are set forth with
14 particularity in the appended claims. However the invention itself, both as to organization
15 and method of operation, together with further objects and advantages thereof may be best
16 be understood by reference to the following description taken in conjunction with the
17 accompanying drawings in which:

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram showing a waveform commonly used to control the amount of light passing through liquid crystal shutter glasses.

4 Figure 3 is a schematic diagram showing a modified voltage waveform applied to
5 liquid crystal shutter glasses in accordance with the present invention.

6 Figure A. is a schematic diagram showing a modified voltage waveform applied to
7 liquid-crystal shutter glasses in accordance with the present invention.

8 **Figure 5** is a plan view of liquid crystal shutter glasses modified to provide the
9 voltage waveforms shown in Figures 3 and 4.]

10 **Figure 6** is an embodiment of the **LCSG** similar to the configuration of Figure 5
11 wherein a screen-sized polarizer sheet is placed between the screen bearing the image
12 being viewed a modified **LCSG** viewing device is employed.

14 DESCRIPTION OF THE PREFERRED EMBODIMENT

15 LCSG are usually designed for the “active-closed” configuration, that is, the
16 shutter closes when a voltage is applied. It is understood that the principles described for
17 LCSG operating in the “active-closed” configuration described herein also apply to the
18 “active-open” configuration.

With reference to Figure 1, LCGS lens 10 is comprised of front 11 and rear 12 crossed polarizers with an LC layer 13 therebetween. In the “active-closed” design, crossed linear polarizers 11 and 12 are placed on either side of a liquid crystal cell 13. In the open state, when no voltage is applied across the LC layer 55, the thin layer of LC material in the cell acts as a half-wave retarder, rotating the axis of polarization of the light

1 passing therethrough by 90 degrees. Therefore, light can pass through the two polarizers
2 providing maximum light transmission. A voltage signal V is applied across the LC layer
3 13 by means of a driver 14 which may be housed within a monitor 15. With reference
4 now to Figures 2 and 3, in the "closed" state, when the "optimum" voltage V_c is applied,
5 the magnitude of which will depend on the construction of the LC cell, the LC loses its
6 retardation and does not rotate the polarization of light passing through the front polarizer
7 11. The light is blocked by the crossed polarizers, giving minimum transmission. For
8 intermediate voltages, the rotation of the polarization is not complete, and the
9 transmission of the cells is somewhere between the maximum and minimum states.

10 In a first embodiment of the present invention the voltage signal to the cell is
11 controlled in such a way that the voltage applied in the "open" state is not zero (V_o). The
12 open state remains dark to some degree. A variable resistor 16 may be interposed
13 between the driver 14 and the lens 10 to act as a voltage divider. By varying this voltage
14 between zero and some fraction of V_c , the user can control the amount of darkening and,
15 consequently, the amount of flicker reduction. With reference now to Figures 2 and 3,
16 there are two kinds of signals commonly employed to drive LC shutters: Signal 1, a low-
17 frequency asymmetric signal; and Signal 2, a high frequency modulated signal. In a
18 normal LCSG driver circuit, these signals take the forms shown in Figures 7 and 8. These
19 traces show the signal going to one of the lenses which acts as a shutter. The other
20 shutter (not shown in Figure 1) is driven by identical signals, but 90 degrees out of phase
21 for Signal 1 and 180 degrees out of phase for Signal 2. Positive and negative voltages
22 have the same effect on the LC cell. The mean voltage of either signal is usually zero in
23 order to prevent migration of the LC molecules.

1 Electronic flicker control can be achieved by applying the signals having the form
2 shown in Figures 3 and 4. V_o is changed to vary the amount of light transmission while
3 the mean voltage remains zero. The foregoing embodiment of the invention thereby
4 provides means to reduce flicker. Instead of placing neutral density (ND) filters over the
5 shutters, the invention prevents the shutters from opening fully through an electronic
6 control. Thus, ND filters are not required, and the viewer has complete control over the
7 degree of darkening that any particular scene may require. This method and device is
8 suitable for reducing flutter in many different types of LC shutter glasses.

9 A second embodiment of the present invention, illustrated in Figure 6, provides a
10 means of eliminating a portion of the flicker due to background illumination. The front
11 polarizer, where light enters the shutter is removed and replaced with a transparent
12 element 61. A polarizer 62 of the same orientation as polarizer 11 is placed over the
13 screen of the monitor 15. Thus, light emanating from the screen and entering the LC cell
14 will behave as before. The light will either pass through or be blocked by the shutter
15 depending on the state of the cell, open or closed.

16 Light comprising background light (i.e. light not emanating from monitor 15) will
17 not be polarized when it enters the LC cell. However, not all of this light will pass
18 through the shutter. Consider a shutter system where the front polarizer is vertical and the
19 rear polarizer horizontal. When the shutter is open, only the background light that is
20 vertically polarized will pass through the shutter (after being rotated 90°). When the
21 shutter is closed (no rotation), only horizontally polarized entrance light will pass through.
22 Thus the background illumination that enters the viewer's eye is continuously changing
23 between two different polarizations. However, this does not cause flicker because it is

1 *balanced*, i.e., of equal intensity. Except in rare circumstances, such as reflections from a
2 shiny surface, the viewer 17 does not notice this change and does not perceive flicker.

3 While particular embodiments of the present invention have been illustrated and
4 described, it will be obvious to those skilled in the art that various other changes and
5 modifications can be made without departing from the spirit and scope of the invention.
6 For example, the reference to **LCSG** operating in the “active-open” configuration is only
7 used as an example of the invention and should not limit the scope of the invention. It is
8 therefore intended to cover in the appended claims all such changes and modifications that
9 are within the scope of this invention.

10 What I claim is:

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